

# Asia-Pacific mussel watch: Monitoring contamination of persistent organochlorine compounds in coastal waters of Asian countries

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**Abstract:** Contamination of persistent organochlorines (OCs) such as PCBs (polychlorinated biphenyls), DDT and its metabolites (DDTs), HCH (hexachlorocyclohexane) isomers (HCHs), chlordanes compounds (CHLs), and HCB (hexachlorobenzene) were examined in mussels collected from coastal waters of Asian countries such as Cambodia, China, Hong Kong, India, Indonesia, Japan, Korea, Malaysia, Philippines, Far East Russia, Singapore, and Vietnam in 1994, 1997, 1998, 1999, and 2001 to elucidate the contamination status, distribution and possible pollution sources and to assess the risks on aquatic organisms and human. OCs were detected in all mussels collected from all the sampling sites investigated. Considerable residue levels of p,p'-DDT and  $\alpha$ -HCH were found in mussels and the concentrations of DDTs and HCHs found in mussels from Asian developing countries were higher than those in developed nations suggesting present usage of DDTs and HCHs along the coastal waters of Asian developing countries. On the other hand, lower concentrations of PCBs detected in mussels from Asian developing countries than those in developed countries indicate that PCBs contamination in mussels is strongly related to industrial and activities. To our knowledge, this is a first comprehensive report on monitoring OCs pollution in the Asia-Pacific region. © 2002 Elsevier Science Ltd. All rights reserved.

**Author Keywords:** Asia-Pacific region; Developed nations; Developing countries; Mussels; Organochlorine compounds (OCs)

**Index Keywords:** Chlorine compounds; Coastal zones; Contamination; Isomers; Coastal waters; Marine pollution; 1,1 dichloro 2,2 bis(4 chlorophenyl)ethane; 1,1 dichloro 2,2 bis(4 chlorophenyl)ethylene; 4,4' chlorphenotane; alpha hexachlorocyclohexane; beta hexachlorocyclohexane; chlordanes; chlorphenotane; hexachlorobenzene; hexachlorocyclohexane; lindane; nonachlor; organochlorine derivative; oxychlordanes; polychlorinated biphenyl derivative; unclassified drug; bioaccumulation; coastal water; marine pollution; mollusc; organochlorine; animal tissue; Asia; bioaccumulation; controlled study; developed country; developing country; environmental impact; geographic distribution; mussel; nonhuman; Pacific islands; pollution monitoring; review; sea pollution; seashore; tissue level; water contamination; Animals; Asia; Bivalvia; DDT; Developing Countries; Environmental Monitoring; Environmental Pollutants; Industry;

Insecticides; Lindane; Polychlorinated Biphenyls; Risk Assessment; Asia

Year: 2003

Source title: Marine Pollution Bulletin

Volume: 46

Issue: 3

Page : 281-300

Cited by: 166

Link: Scopus Link

Chemicals/CAS: 1,1 dichloro 2,2 bis(4 chlorophenyl)ethane, 72-54-8; 1,1 dichloro 2,2 bis(4 chlorophenyl)ethylene, 72-55-9; alpha hexachlorocyclohexane, 319-84-6; beta hexachlorocyclohexane, 319-85-7; chlordane, 12789-03-6, 57-74-9; chlorphenotane, 50-29-3; hexachlorobenzene, 118-74-1, 55600-34-5; hexachlorocyclohexane, 608-73-1; lindane, 58-89-9; nonachlor, 3734-49-4; oxychlordane, 27304-13-8; DDT, 50-29-3; Environmental Pollutants; Insecticides; Lindane, 58-89-9; Polychlorinated Biphenyls

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ISSN: 0025326X

CODEN: MPNBA

DOI: 10.1016/S0025-326X(02)00400-9

PubMed ID: 12604061

Language of Original Document: English

Abbreviated Source Title: Marine Pollution Bulletin

Document Type: Review

Source: Scopus

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#### References:

- Alvarez Pineiro, M.E., Simal Lozano, J., Lage Yusty, M.A., Organochlorine compounds in mussels of the Estuarine Bay of Galicia (North-West Spain) (1995) *Mar. Pollut. Bull.*, 30, pp. 484-487
- (2001) *Bottom line*, p. 53. , Asiaweek, November 23
- Binelli, A., Bacchetta, R., Vailati, G., Galassi, S., Provini, A., DDT contamination in Lake Maggiore (N. Italy) and effects on zebra mussel spawning (2001) *Chemosphere*, 45, pp. 409-415
- Calamari, D., Bacci, E., Focardi, S., Gaggi, C., Morosini, M., Vighi, M., Role of plant biomass in the global environmental partitioning of chlorinated hydrocarbons (1991) *Environ. Sci. Technol.*, 25, pp. 1489-1495
- Cheong, L., (1982) Country report: Singapore: Bivalve culture in Asia and the Pacific: Proceedings of a Workshop Held in Singapore, pp. 69-71. , Davy, F.B., Graham, M., 16-19 February 1982. Ottawa, Canada: International Development Research Centre
- Colborn, T., Smolen, M.J., Epidemiological analysis of persistent organochlorine contaminants in cetaceans (1996) *Rev. Environ. Contam. Toxicol.*, 146, pp. 91-172
- Connor, L., Johnson, M.S., Copplestone, D., Leah, R.T., Recent trends in organochlorine residues in mussels (*Mytilus edulis*) from the Mersey Estuary (2001) *Mar. Environ. Res.*, 52, pp. 397-411
- Dave, P.P., India: A generics giant (1996) *Farm Chem. Int.*, 10, pp. 36-37
- De Brito, A.P.X., Bruning, I.M.R.D.A., Chlorinated pesticides in mussels from Guanabara Bay, Rio de Janeiro, Brazil (2002) *Mar. Pollut. Bull.*, 44, pp. 71-81
- Duinker, J.C., Schulz, D.E., Petrić, G., Multidimensional gas chromatography with electron capture detection for determination of toxic congeners in polychlorinated biphenyl mixtures (1988) *Anal. Chem.*, 6, pp. 478-482
- Marketing in the Asia-Pacific (1996) *Farm Chem. Int.*, pp. 56-68. , September
- Goldberg, E.D., Bowen, V.T., Farrington, J.W., Harvey, G., Martin, J.H., Parker, P.L., Risebrough, R.W., Gamble, E., The mussel watch (1978) *Environ. Conserv.*, 5, pp. 101-125
- Han, B.C., Jeng, W.L., Hung, T.C., Ling, Y.C., Shieh, M.J., Chien, L.C., Estimation of metal and organochlorine pesticides exposures and potential health threat by consumption of oysters in Taiwan (2000) *Environ. Pollut.*, 109, pp. 147-156
- Hong, H., Chen, W.X.L., Wang, X., Zhang, L., Distribution and fate of organochlorine pollutants in the Pear River Estuary (1999) *Mar. Pollut. Bull.*, 39, pp. 376-382
- Hong, H., Wang, X., Xu, L., Chen, W., Zhang, L., Zhang, Z., Trace organic pollutants in the Southeast estuarine environments of China (2000) *J. Environ. Sci. Heal. A*, 35, pp. 1833-1847
- Hong, H., Xu, L., Cheng, J.C., Wong, Y.S., Wan, T.S.M., Environmental fate and chemistry of organic pollutants in the sediment of Xiamen and Victoria Harbours (1995) *Mar. Pollut. Bull.*, 31, pp. 229-236
- Ivanov, V., Sandell, E.N., Characterization of polychlorinated biphenyl isomers in Sovol and trichlorobiphenyl formulations by high-resolution gas chromatography with electron capture detection and high-resolution gas chromatography-mass spectrometry technique (1992) *Environ. Sci. Technol.*, 26, pp. 2012-2017
- Iwata, H., Tanabe, S., Sakai, N., Tatsukawa, R., Distribution of persistent organochlorines in the oceanic air and surface seawater and the role of ocean on their global transport and fate (1993) *Environ. Sci. Technol.*, 27, pp. 1071-1098
- Iwata, H., Tanabe, S., Ueda, K., Tatsukawa, R., Persistent organochlorine residues in air, water, sediments, and soils from the Lake Baikal region, Russia (1995) *Environ. Sci. Technol.*, 29, pp. 801-972
- Kan-atireklap, S., Tanabe, S., Sanguansin, J., Tabucanon, M.S., Hungspreugs, M., Contamination by butyltin compounds and

- organochlorine residues in green mussel (*Perna viridis*, L.) from Thailand coastal waters (1997) *Environ. Pollut.*, 97, pp. 79-89
- Kan-atiyeklap, S., Yen, N.T.H., Tanabe, S., Subramanian, A.N., Butyltin compounds and organochlorine residues in green mussel (*Perina viridis* L.) from India (1998) *Toxicol. Environ. Chem.*, 67, pp. 409-424
  - Kannan, K., Tanabe, S., Tatsukawa, R., Geographical distribution and accumulation features of organochlorine residues in fish in Tropical Asia and Oceania (1995) *Environ. Sci. Technol.*, 29, pp. 2673-2683
  - Kannan, K., Tanabe, S., Giesy, J.P., Tatsukawa, R., Organochlorine pesticides and polychlorinated biphenyls in foodstuffs from Asian and Oceanic countries (1997) *Rev. Environ. Contam. Toxicol.*, 15, pp. 1-55
  - Klumpp, D.W., Huansheng, H., Humphrey, C., Xinhong, W., Codi, S., Toxic contaminants and their biological effects in coastal waters of Xiamen, China I. Organic pollutants in mussel and fish tissues (2002) *Mar. Pollut. Bull.*, 44, pp. 752-760
  - Kuklick, J.R., Bidleman, T.F., McConnell, L.L., Walia, D.M., Ivanov, P.G., Organochlorines in the water and biota of Lake Baikal, Siberia (1994) *Environ. Sci. Technol.*, 28, pp. 31-37
  - Kunisue, T., Minh, T.B., Fukuda, K., Watanabe, M., Tanabe, S., Titenko, A.M., Seasonal variation of persistent organochlorine accumulation in birds from Lake Baikal, Russia, and the role of the south Asian region as source of pollution for wintering migrants (2002) *Environ. Sci. Technol.*, 36, pp. 1396-1404
  - Kunisue, T., Watanabe, M., Subramanian, A., Sethuraman, A., Titenko, A.M., Qui, V., Prudente, M., Tanabe, S., Accumulation features of persistent organochlorines in resident and migratory birds from Asia *Environ. Pollut.*, , in press
  - Lee, K.M., Kruse, H., Wasserman, O., Seasonal fluctuation of organochlorines in *Mytilus edulis* L. from the South West Baltic Sea (1996) *Chemosphere*, 32, pp. 1883-1895
  - Li, Y.F., Bidelman, T.F., Barrie, L.A., McConnell, L.L., Global hexachlorocyclohexane use trends and their impact on the Arctic atmospheric environment (1998) *Geophys. Res. Lett.*, 25, pp. 39-41
  - Li, Y.F., Global technical hexachlorocyclohexane usage and its contamination consequences in the environment: From 1994 to 1997 (1999) *Sci. Total Environ.*, 232, pp. 121-158
  - Loganathan, B.G., Tanabe, S., Hidaka, Y., Kawano, M., Hidaka, H., Tatsukawa, R., Temporal trends of persistent organochlorine residues in human adipose tissue from Japan, 1928-1985 (1993) *Environ. Pollut.*, 81, pp. 31-39
  - McConnell, L.L., Kuklick, J.R., Bidleman, T.F., Ivanov, G.P., Chernyak, S.M., Air-water gas exchange of organochlorine compounds in Lake Baikal, Russia (1996) *Environ. Sci. Technol.*, 30, pp. 2975-2983
  - Minh, T.B., Watanabe, M., Nakata, H., Tanabe, S., Jefferson, T.A., Contamination by persistent organochlorines in small cetaceans from Hong Kong coastal waters (1999) *Mar. Pollut. Bull.*, 39, pp. 383-392
  - Minh, T.B., Watanabe, M., Tanabe, S., Miyazaki, N., Jefferson, T.A., Prudente, M.S., Subramanian, A., Karuppiah, S., Widespread contamination by tris(4-chlorophenyl)methane and tris(4-chlorophenyl)methanol in cetaceans from North Pacific and Asian coastal waters (2000) *Environ. Pollut.*, 110, pp. 459-468
  - Minh, T.B., Kunisue, T., Yen, T.H., Watanabe, M., Tanabe, S., Hue, N.D., Qui, V., Persistent organochlorine residues and their bioaccumulation profile in resident and migratory birds from North Vietnam (2002) *Environ. Toxicol. Chem.*, 21, pp. 2108-2118
  - Nakata, H., Tanabe, S., Tatsukawa, R., Amano, M., Miyazaki, N., Petrov, E.A., Persistent organochlorine residues and their accumulation kinetics in Baikal seal (*Phoca sibirica*) from Lake Baikal, Russia (1995) *Environ. Sci. Technol.*, 29, pp. 2877-2885
  - Nhan, D.D., Am, N.M., Hoi, N.C., Dieu, L.V., Carvalho, F.P., Vieleneuve, J.P., Cattini, C., Organochlorine pesticides and PCBs in the Red River Delta, North Vietnam (1998) *Mar. Pollut. Bull.*, 36, pp. 742-749
  - Nhan, D.D., Am, N.M., Carvalho, F.P., Vieleneuve, J.P., Cattini, C., Organochlorine pesticides and PCBs along the coast of North Vietnam (1999) *Sci. Total Environ.*, 237-238, pp. 363-371
  - Nhan, D.D., Carvalho, F.P., Am, N.M., Tuan, N.Q., Yen, N.T.H., Vieleneuve, J.P., Cattini, C., Chlorinated pesticides and PCBs in sediments and molluscs from freshwater canals in the Hanoi region (2000) *Environ. Pollut.*, 112, pp. 311-320

- Phillips, D.J.H., Organochlorines and trace metals in green-lipped mussels *Perna viridis* from Hong Kong water: A test of indicator ability (1985) *Mar. Ecol. Prog. Ser.*, 21, pp. 251-258
- Phillips, D.J.H., Trace metals and organochlorines in the coastal waters of Hong Kong (1989) *Mar. Pollut. Bull.*, 20, pp. 319-327
- Prudente, M., Tanabe, S., Watanabe, M., Subramanian, A., Miyazaki, N., Suarez, P., Tatsukawa, R., Organochlorine contamination in some odontoceti species from the North Pacific and Indian Ocean (1997) *Mar. Environ. Res.*, 44, pp. 415-427
- Prudente, M., Ichihashi, H., Kan-atireklap, S., Watanabe, I., Tanabe, S., Butyltins, organochlorines and metal levels in green mussels, *Perna viridis* L. from coastal waters of the Philippines (1999) *Fish. Sci.*, 65, pp. 441-447
- Ramesh, A., Tanabe, S., Subramanian, A.N., Mohan, D., Venugopalan, V.K., Tatsukawa, R., Persistent organochlorine residues in green mussels from coastal waters of South India (1990) *Mar. Pollut. Bull.*, 21, pp. 587-590
- Roe, S.L., MacIsaac, H.J., Temporal variation of organochlorine contaminants in the zebra mussel *Dreissena polymorpha* in Lake Erie (1998) *Aquat. Toxicol.*, 41, pp. 125-140
- Sericano, J.L., Wade, T.L., Jackson, T.J., Brooks, J.M., Tripp, B.W., Farrington, J.W., Mee, L.D., Goldberg, E.D., Trace organic contamination in the Americas: An overview of the US national status and trends and international 'Mussel watch' Programmes (1995) *Mar. Pollut. Bull.*, 31, pp. 214-225
- Takahashi, S., Lee, J.S., Tanabe, S., Contamination and specific accumulation of organochlorine and butyltin compounds in deep-sea organisms collected from Suruga Bay, Japan (1998) *Sci. Total Environ.*, 214, pp. 49-65
- Takahashi, S., Tanabe, S., Kawaguchi, K., Organochlorine and butyltin residues in mesopelagic myctophid fishes from the western North Pacific (2000) *Environ. Sci. Technol.*, 34, pp. 5129-5136
- Tan, G.H., Vijayaletchumy, K., Organochlorine pesticide residue levels in Peninsular Malaysian Rivers (1994) *Bull. Environ. Contam. Toxicol.*, 53, pp. 351-356
- Tanabe, S., Asian developing regions: Persistent organic pollutants in seas (2000) *Sea at the Millennium: An Environmental Evaluation*, pp. 447-462. , C.R.C. Sheppard. Amsterdam: Elsevier Science
- Tanabe, S., Iwata, H., Tatsukawa, R., Global contamination by persistent organochlorines and their ecotoxicological impact on marine mammals (1994) *Sci. Total Environ.*, 154, pp. 163-177
- Tanabe, S., Prudente, M.S., Kan-atireklap, S., Subramanian, A., Mussel watch: Marine pollution monitoring of butyltins and organochlorines in coastal waters of Thailand, Philippines and India (2000) *Ocean Coast. Manage.*, 43, pp. 819-839
- Ueno, D., Takahashi, S., Tanabe, S., Ikeda, K., Koyama, J., Uptake kinetics of persistent organochlorines in mussels through the transplantation experiment (1999) *J. Environ. Chem.*, 9, pp. 369-378. , (in Japanese)
- Ueno, D., Takahashi, S., Tanaka, H., Subramanian, A.N., Fillmann, G., Nakata, H., Lam, P.K.S., Tanabe, S., Global pollution monitoring of PCBs and organochlorine pesticides using Skipjack Tuna as bioindicator *Arch. Environ. Contam. Toxicol.*, , in press
- Van-Birgelen, A.P.J.M., Hexachlorobenzene as a possible major contributor to the dioxin activity of human milk (1998) *Environ. Health Perspect.*, 106, pp. 683-688
- Watanabe, S., Laovakul, W., Boonyathumanondh, R., Tabucanon, M.S., Ohgaki, S., Concentrations and composition of PCB congeners in the air around stored used capacitors containing PCB insulator oil in a suburb of Bangkok, Thailand (1996) *Environ. Pollut.*, 92, pp. 289-297
- Wu, Y., Zhang, J., Zhou, Q., Persistent organochlorine residues in sediments from Chinese river/estuary systems (1999) *Environ. Pollut.*, 96, pp. 217-226
- Yamada, H., Takayanagi, K., Tateishi, M., Tagata, H., Ikeda, K., Organotin compounds and polychlorinated biphenyls of livers in squid collected from coastal waters and oceans (1997) *Environ. Pollut.*, 96, pp. 217-226

- Zhulidov, A.V., Headley, J.V., Pavlov, D.F., Robarts, R.D., Korotova, L.G., Vinnikov, Y.Y., Zhulidova, O.V., Riverine fluxes of the persistent organochlorine pesticides hexachlorocyclohexane and DDT in the Russian Federation (2000) *Chemosphere*, 41, pp. 829-841